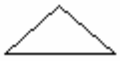
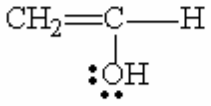
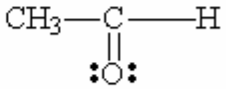
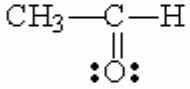
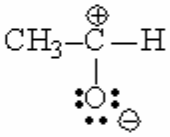
MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

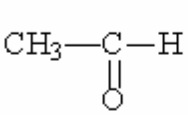
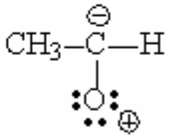
1) Which of the following statements about benzene is correct?
A) It has no delocalized electrons.
B) All of the carbon atoms are sp^3 hybridized.
C) The carbon–hydrogen bonds are not the same length.
D) The carbon–carbon bond length is longer than that of ethane.
E) It is a planar molecule.

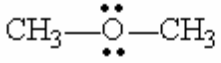
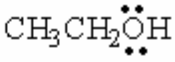
2) Which of the following pairs are resonance structures?

I. $CH_2=CHCH_3$ and 

II.  and 

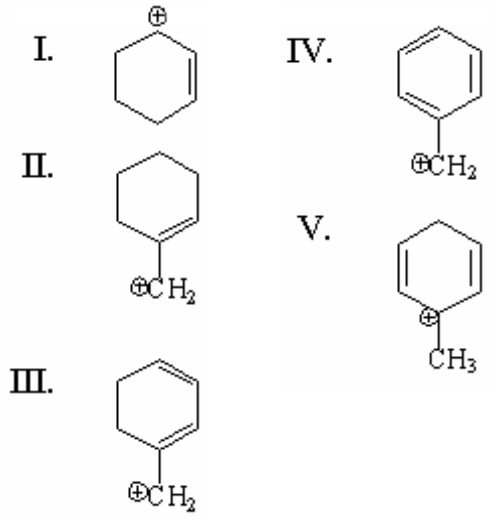
III.  and 

IV.  and 

V.  and 

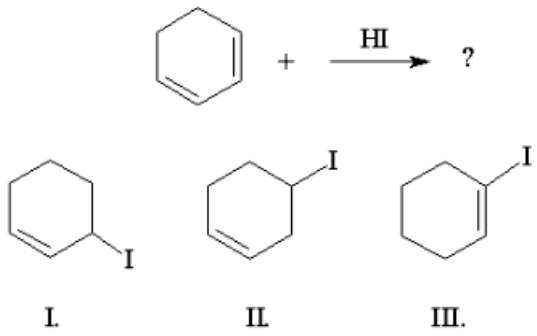
A) I B) II C) III D) IV E) V

3) Which of the following is a benzylic cation?



A) I B) II C) III D) IV E) V

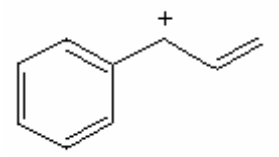
4) Which of the following is/are the major product(s) of the following reaction?



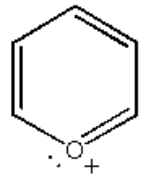
A) I and III B) I C) I and II D) II E) III

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

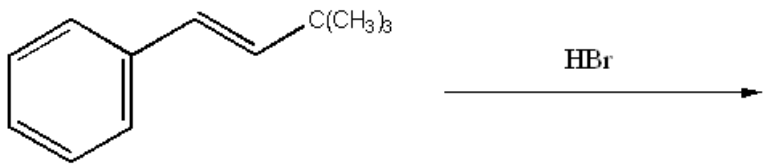
5) Draw the important resonance contributing forms for the structure shown below.



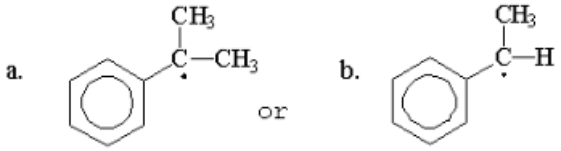
6) Draw all major resonance contributors of the species below.



7) Provide the major organic product of the following reaction.



8) Which of the following compounds is more stable? Explain.



MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

9) What is/are the product(s) of the following reaction?

$CH_2{=}CHCH{=}CH_2 + HBr \longrightarrow ?$

I. $CH_2{=}CHCHCH_3$ (Br)

II. $CH_3CH(Br){-}CHCH_3$ (Br)

III. $CH_2(Br){-}CH{=}CHCH_3$

A) I only B) II only C) III only D) I and II E) I and III

10) What is/are the product(s) from the following reaction?

$$CH_2{=}CHCH{=}CH_2 + HBr \xrightarrow{45^\circ} ?$$

I. $CH_2(Br)CH_2CH{=}CH_2$

II. $CH_3CH(Br)CH{=}CH_2$

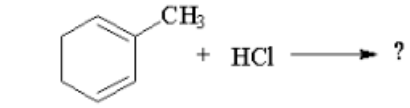
III. $CH_3CH{=}CH(Br)CH_2$

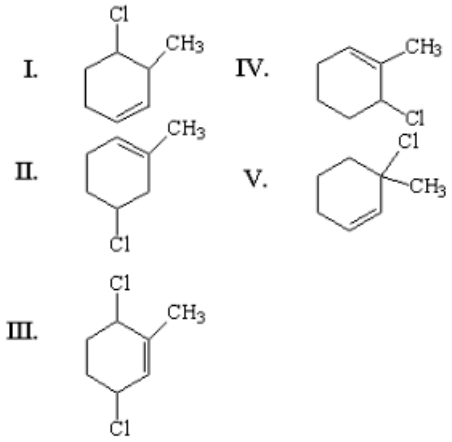
A) I only B) II only C) III only D) I and II E) II and III

11) What compound results from the 1, 4–addition of one equivalent of HBr to 1, 3–butadiene?

A) 3–bromo–1–butene
B) 4–bromo–1–butene
C) 1–bromo–1–butene
D) 1–bromo–2–butene
E) 2–bromo–2–butene

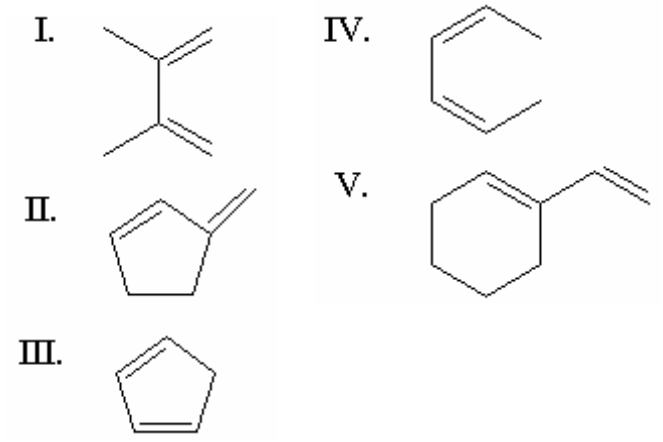
12) What is the kinetic product for the following reaction?





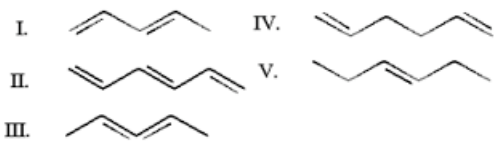
A) I B) II C) III D) IV E) V

13) Which of the following dienes is the most reactive in a Diels–Alder reaction?



A) I B) II C) III D) IV E) V

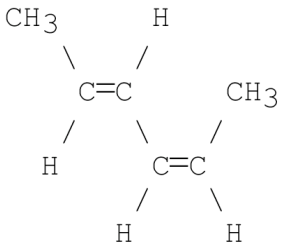
14) Which of the following is an isolated diene?



A) I B) II C) III D) IV E) V

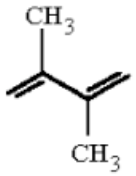
SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

15) Name the following compound:

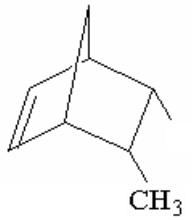


16) Consider the hydrogenation reaction of each compound listed and rank the compounds in order of increasing ΔH° of this reaction. The most negative ΔH° should be listed first.cis–2–pentene, 2, 3–pentadiene, and trans–1, 3–pentadiene

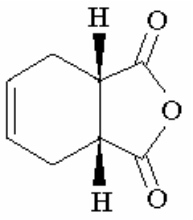
17) Draw the structure of the major product which results when the diene shown is treated with HBr at –80°C.



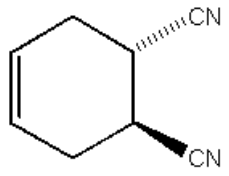
18) What diene and what dieneophile could be used to prepare the following?



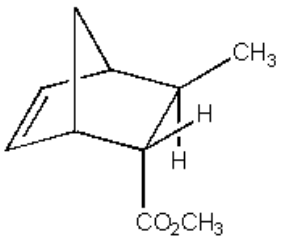
19) What diene and dienophile would react to give the product below?



20) What diene and dienophile should be used to synthesize the compound below?

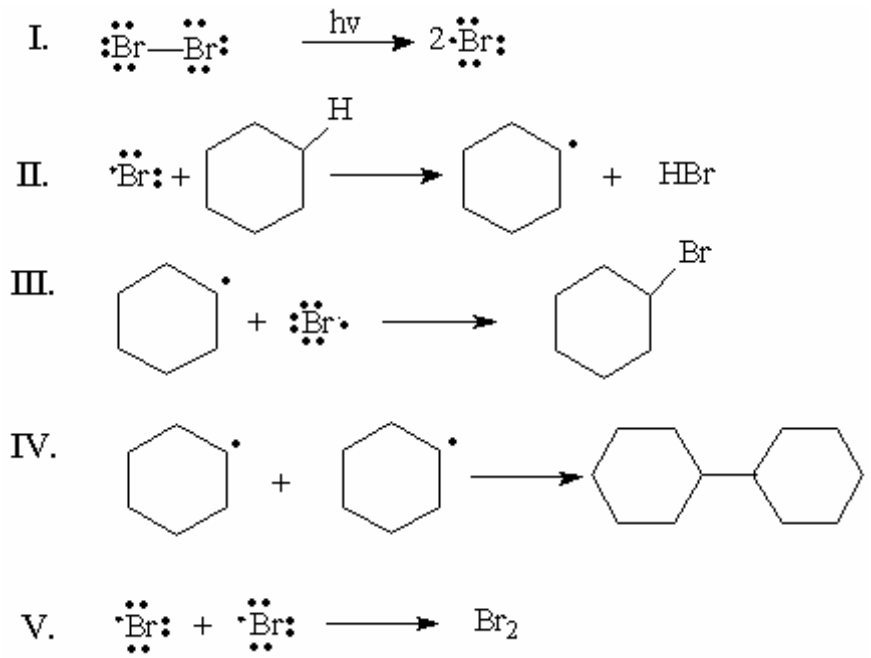


21) What diene and dienophile should be used to synthesize the compound below?



MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

22) Which of the following is the rate–determining step for the monobromination of cyclohexane?



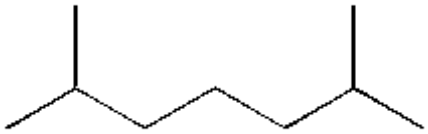
A) I B) II C) III D) IV E) V

23) Which of the following is a chain propagation step in the free radical chlorination of methane?

A) $\cdot CH_3 + CH_4 \rightarrow CH_4 + \cdot CH_3$ B) $CH_4 + Cl\cdot \rightarrow \cdot CH_3 + HCl$

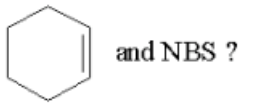
C) $Cl\cdot + \cdot CH_3 \rightarrow CH_3Cl$ D) $Cl_2 \rightarrow 2\ Cl\cdot$

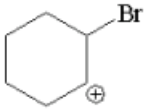
24) How many distinct monochlorinated products, including stereoisomers, can result when the alkane below is heated in the presence of Cl_2?

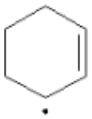


A) 3 B) 4 C) 5 D) 6 E) 7

25) Which of the following is not an intermediate or product in the reaction of



I. Br_2
II. Br•
III. 

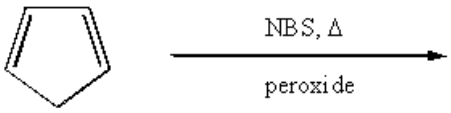
IV. 
V. HBr

A) I B) II C) III D) IV E) V

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

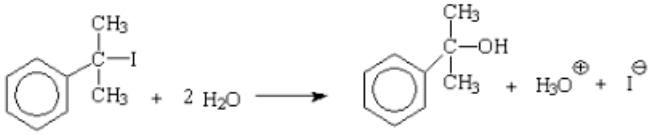
26) How many monochlorinated products would be obtained from 2–methylbutane? Show the structures and give their IUPAC names.

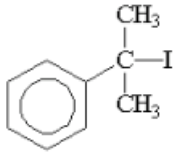
27) Provide the major organic product of the following.



MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

28) What is the nucleophile in the reaction shown below?



I. 

III. $H_3O^{\oplus}$
IV. $I^{\ominus}$
V. $HO^{\ominus}$

II. H_2O

A) I B) II C) III D) IV E) V

29) Which of the following S_N2 reactions is the <u>slowest</u>?

A) $CH_3CH_2CH_2I + HO^- \rightarrow CH_3CH_2CH_2OH + I^-$

B) $CH_3CH_2CH_3Br + HO^- \rightarrow CH_3CH_2CH_3OH + Br^-$

C)

D) $CH_3CH_2CH_3F + HO^- \rightarrow CH_3CH_2CH_2OH + F^-$

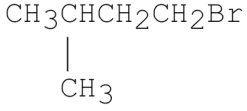
E) $CH_3CH_2CH_2Cl + HO^- \rightarrow CH_3CH_2CH_2OH + Cl^-$

30) Which of the following is the best leaving group?

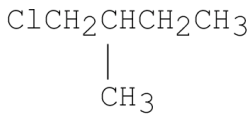
A) Cl^- B) I^- C) Br^- D) F^- E) HO^-

31) Which of the following alkyl halides gives the slowest S_N1 reaction?

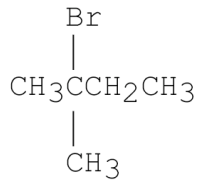
A)



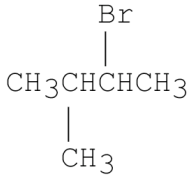
B)



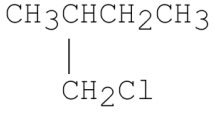
C)



D)



E)



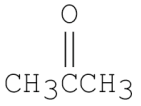
32) Which of the following factors has <u>no</u> effect on the rate of S_N1 reactions?

A) the concentration of the alkyl halide
B) the concentration of the nucleophile
C) the nature of the leaving group
D) the value of the rate constant
E) the nature of the alkyl halide

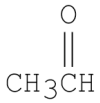
33) Which of the following alkyl bromides undergoes solvolysis in methanol without rearrangement?
A) (S)–3–bromo–2–methylpentane
B) (R)–3–bromo–2–methylpentane
C) (S)–2–bromo–3–ethylpentane
D) (R)–2–bromo–3–ethylpentane
E) 3–bromo–3–ethylpentane

34) The specific rotation of optically pure (R)–sec–butyl alcohol is –13.52°. An optically pure sample of (R)–sec–butyl bromide was converted into the corresponding sec–butyl alcohol via an S_N2 reaction. What is the specific rotation of the product, assuming 100% yield?
A) +13.52°
B) between 0° and –13.52°
C) zero
D) –13.52°
E) between 0° and +13.52°

35) Which of the following solvents is <u>protic</u>?
A)

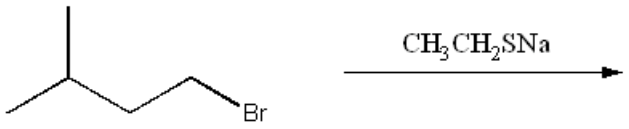


B) $CH_3CH_2CH_2Cl$
C) $CH_3CH_2OCH_3$
D) CH_3CH_2OH
E)



SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

36) Provide the structure of the major organic product of the following reaction.



37) Provide the structure of the major organic product of the following reaction.